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Substitution in Multi-Step Linear Equations

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WHAT'S COVERED

In this lesson, you will learn how to use the Substitution Property of Equality to rewrite an expression for another variable. Specifically, this lesson will cover:

1. Substitution Property of Equality

The Substitution Property of Equality allows us to swap or substitute equivalent quantities in expressions and equations.

EXAMPLE Evaluate $2x+3$ if $x=3$.

$2x+3$	Substitute 3 in for *x*, because they are equal
$2(3)+3$	Evaluate 2(3)
$6+3$	Add 6 and 3
9	Our Solution

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2. Substituting Expressions in Equations

Sometimes, we are given an expression for the variable, rather than a single value. We can still use the Substitution Property of Equality to simplify expressions and solve equations. Most often, this requires distribution after substituting, in order to simplify the equation or expression.

EXAMPLE Substitute $x=3a-2$ in the equation $P=0.5x+12$.

$P=0.5x+12$	Substitute $3a-2$ in for *x*, because they are equal
$P=0.5(3a-2)+12$	Distribute 0.5 into $3a-2$
$P=(1.5a-1)+12$	Combine like terms, -1 and 12
$P=1.5a+11$	Our Solution

HINT

If there is a coefficient in front of the variable that is substituted with an expression, it will require that we distribute it into the newly substituted expression in order to simplify.

3. Substituting to Solve an Equation

Let's apply the concept of substitution to solve an equation.

> EXAMPLE Suppose you sell gift bags from a kiosk at a local strip mall. Each gift bag costs $7, and you received $15 in tips for the day. We can represent your profit with the equation $R = 7x + 15$, where R is revenue, and x is the number of gift bags sold. (To obtain this equation, 7 is multiplied by x to represent revenue from sales, and 15 is added to account for the tips.)
>
> You figure that you averaged 8 sales per hour, and at the end of the day, a customer bought 10 of them for a party she is attending. We can represent the number of gift bags sold by the equation $x = 8t + 10$, where x is the number of gift bags sold, and t is the time in hours. (To obtain this equation, 8 is multiplied by t to represent 8 bags sold each hour, and we add 10 to account for the customer who bought 10 for her party.)
>
> Let's take a look at our equations:
>
> $$R = 7x + 15$$
> $$x = 8t + 10$$
>
> How long did it take to generate $253 in revenue? Notice that we can substitute $253 in for R, but we want to solve for t, time. One method would be to solve for x in the first equation, and then substitute that value in order to solve for t. Another method involves making all the necessary algebraic substitutions first and then solving a simplified equation.
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> | | |
> |---|---|
> | $R = 7x + 15$ | Substitute $253 in for revenue, R |
> | $253 = 7x + 15$ | Now substitute $8t + 10$ in for x, because they are equal |
> | $253 = 7(8t + 10) + 15$ | Distribute 7 into $8t + 10$ |
> | $253 = 56t + 70 + 15$ | Combine like terms, 70 and 15 |
> | $253 = 56t + 85$ | Subtract 85 from both sides |
> | $168 = 56t$ | Divide both sides by 56 |
> | $3 = t$ | Our Solution |
>
> This means that $253 was generated after 3 hours of selling gift bags. Not bad!

SUMMARY

The **substitution property of equality** states that we can **substitute an expression** that is equal to some variable into another equation or expression containing that same variable. After you substitute, you can simplify and/or **solve the equation**.